



CORTIVIS
QLK6-CT-2001-00279



Neural Prostheses for the Blind

**2nd European School of
Neuroengineering
“M. Grattarola”**

**June 9-12, 2004
Genova, Italy**

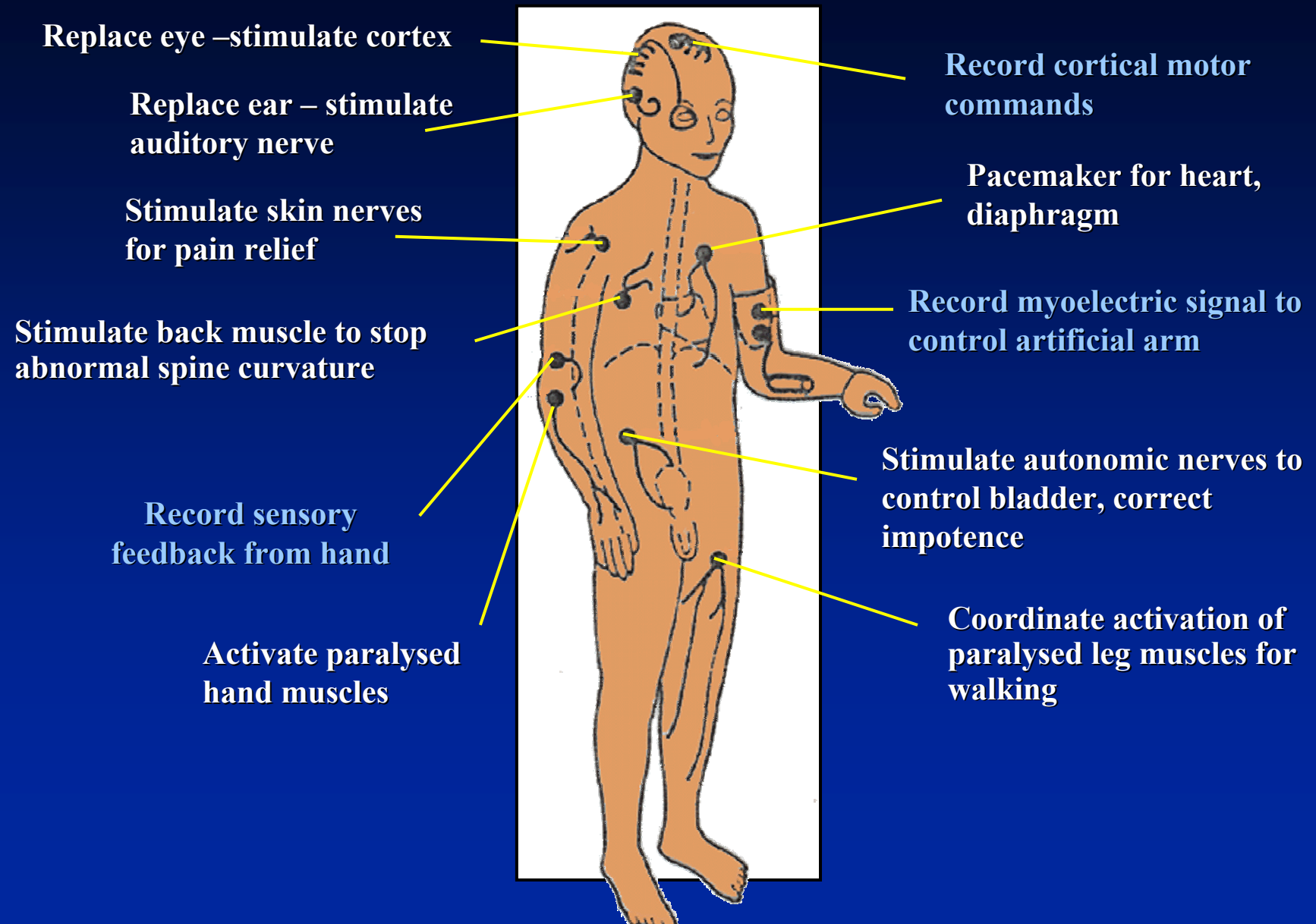
E. Fernández, MD, Ph.D.

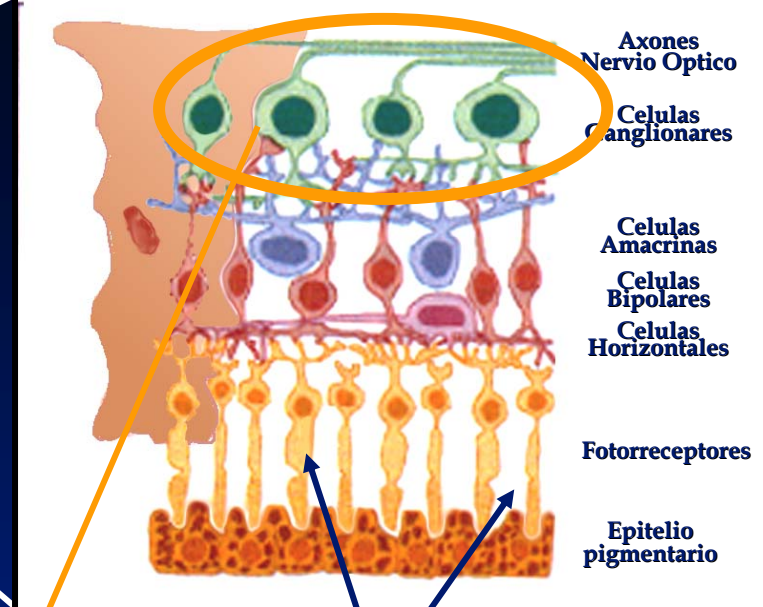
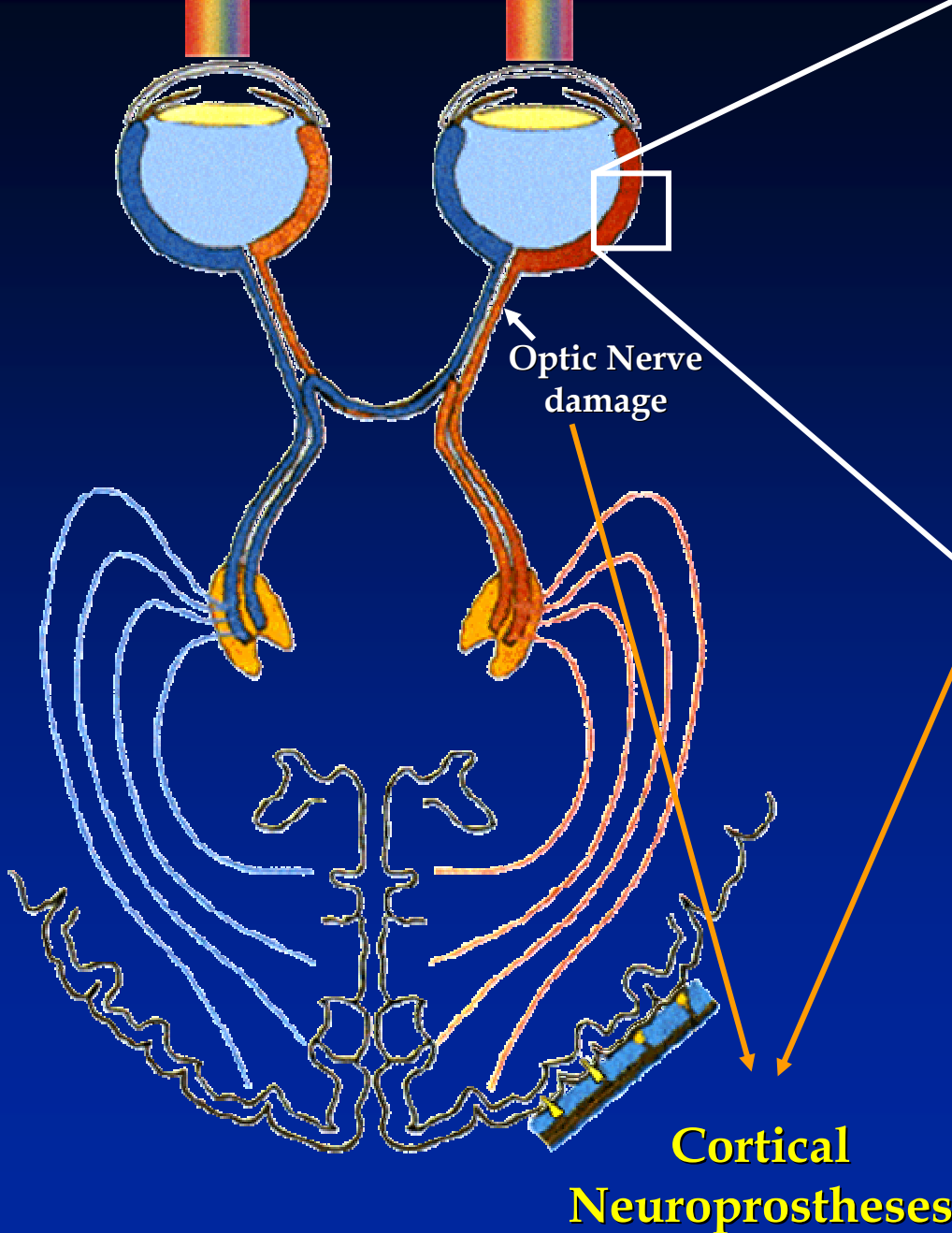


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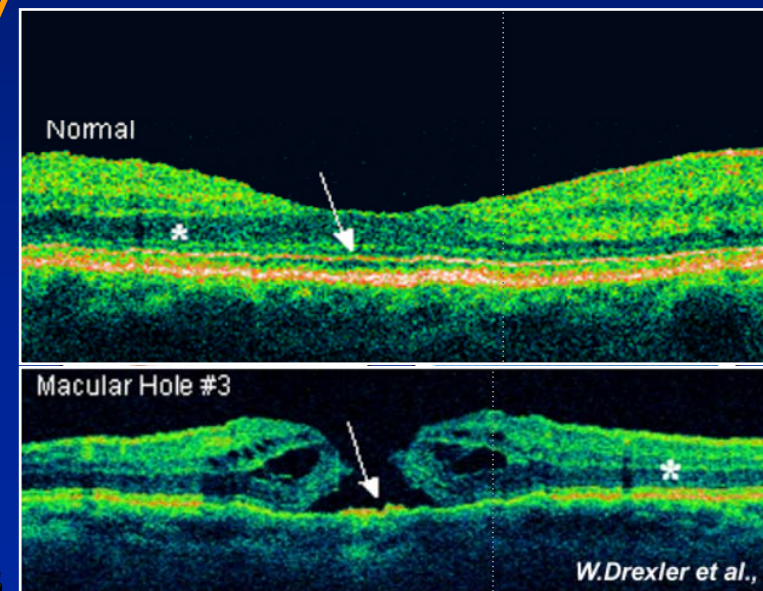


Neuroprosthetic interfaces with the nervous system





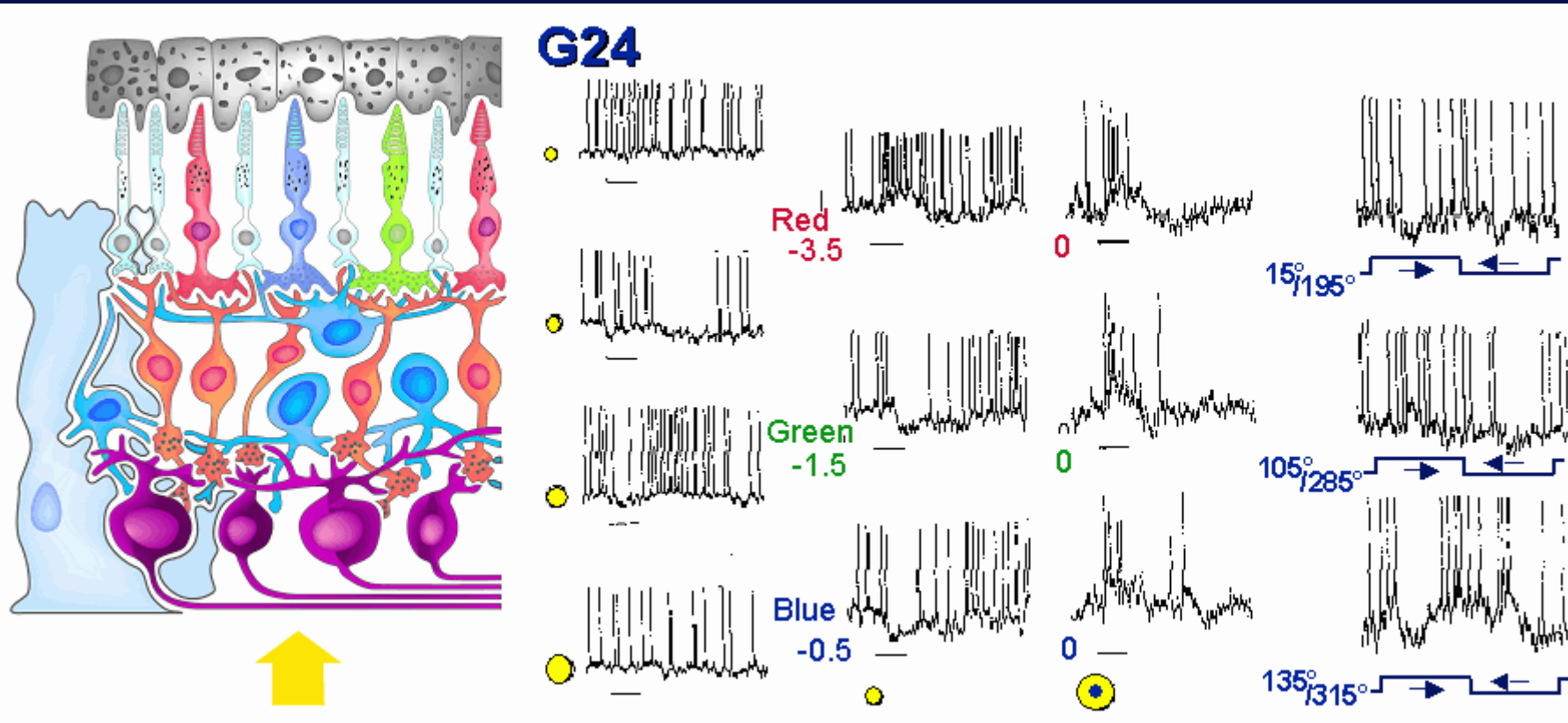
Degeneration (RP, DM)



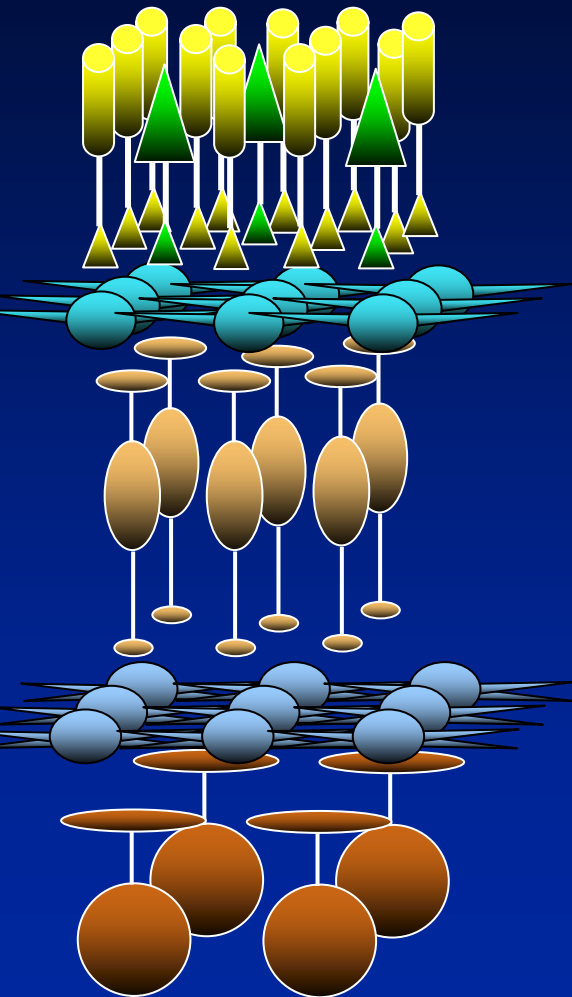
The problem is not to transmit a image with a high resolution, but to send useful information to the right locations inside the SNC.

- ✓ **It is important to know how the visual information is encoded in the retina.**

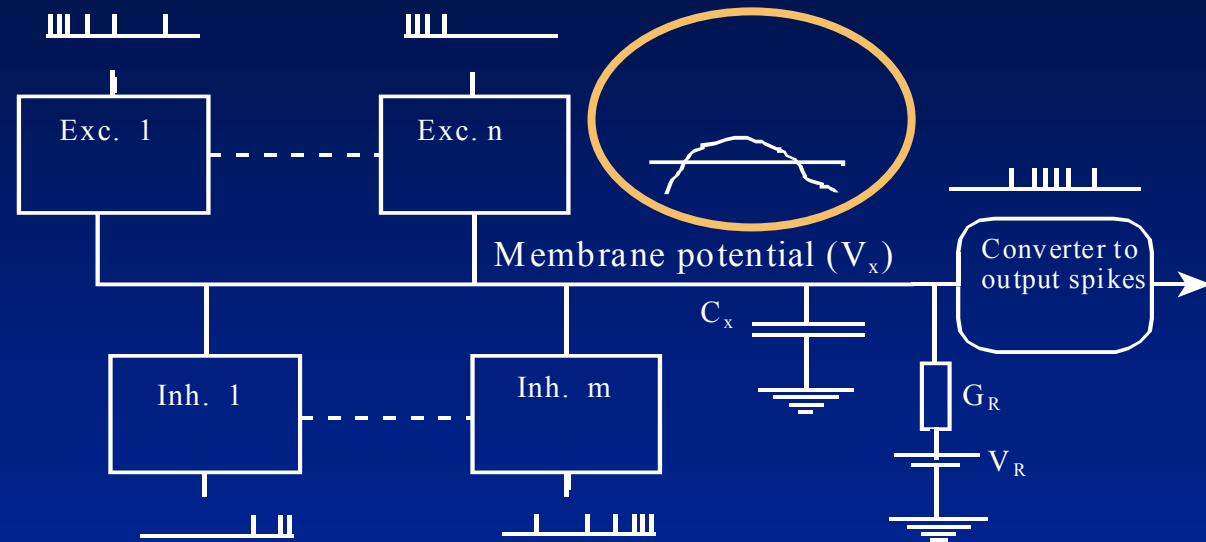
Ganglion cell spike trains are the result of extensive signal processing in the retinal network



Development of a reconfigurable bioinspired visual processing front-end (artificial retina)



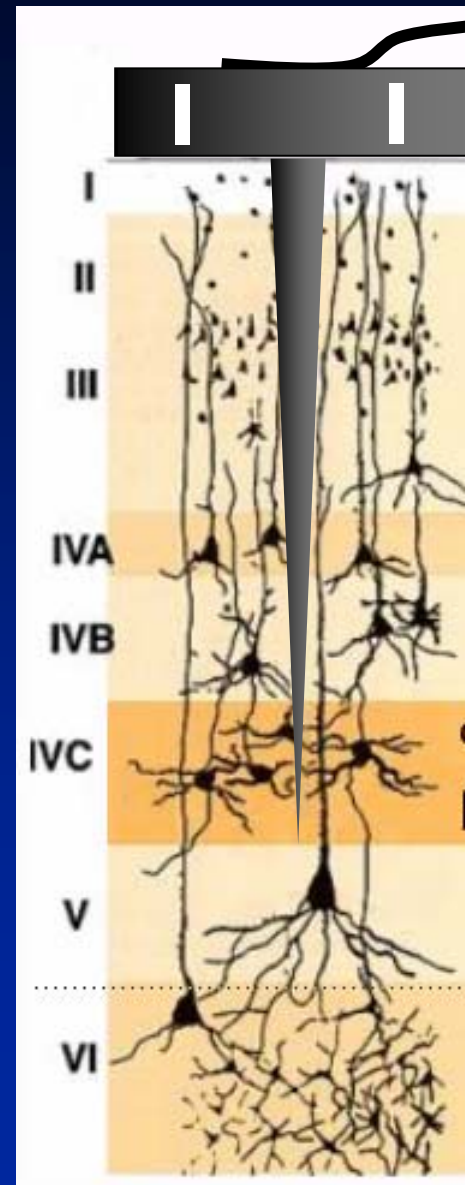
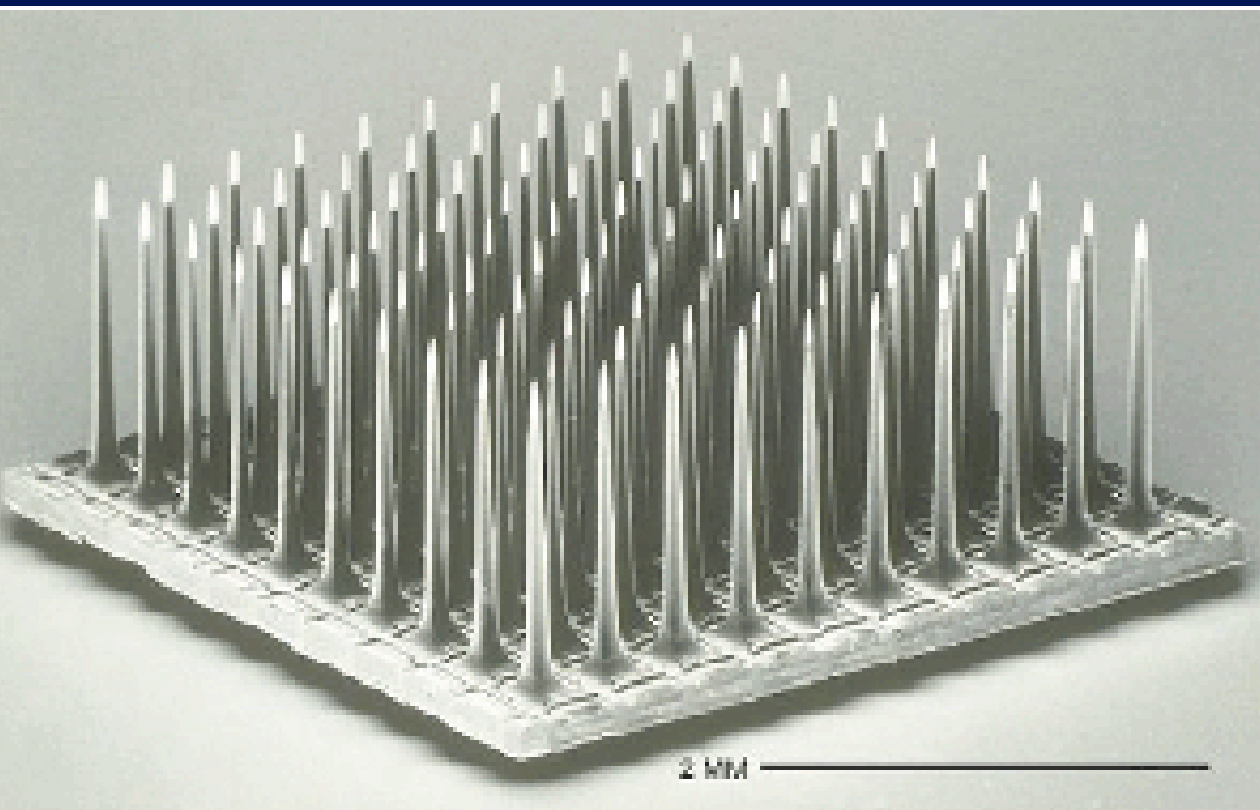
Generation of output spikes

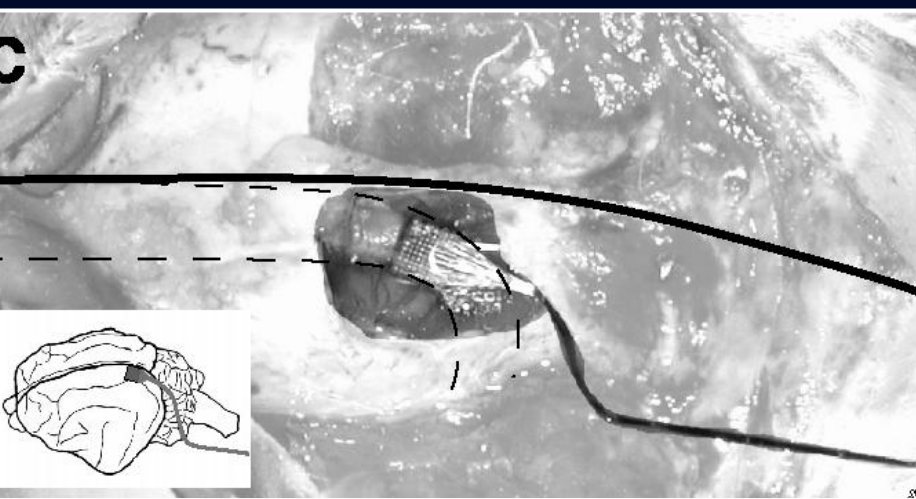


Different approaches:

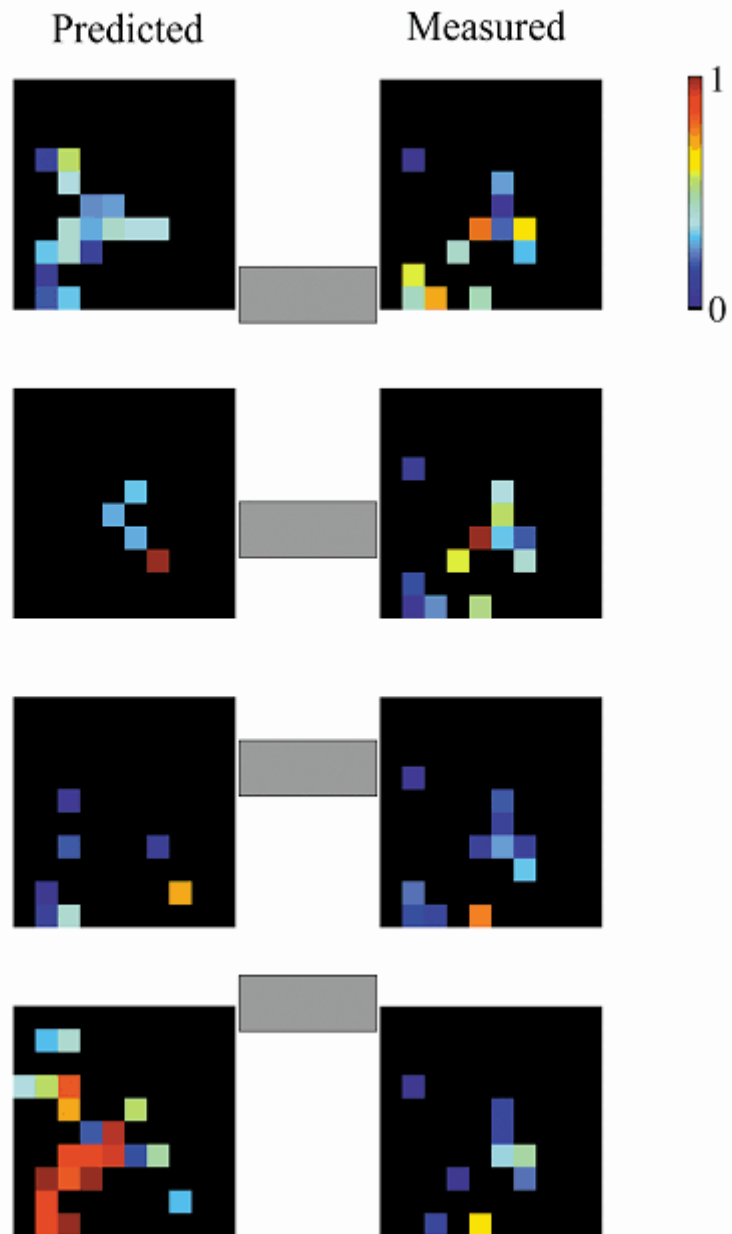
- Phase coding (firing-time): $t_d(V_x)$
- Spike frequency coding (firing-rate): $F(V_x)$

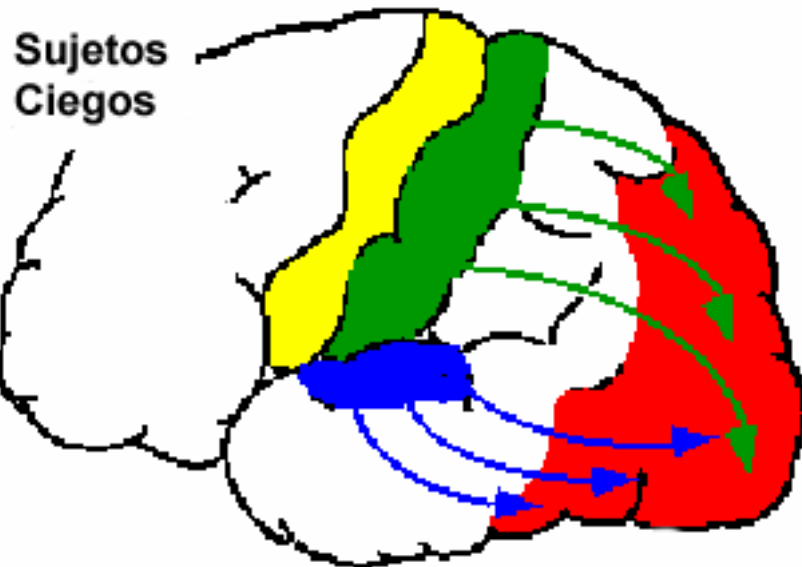
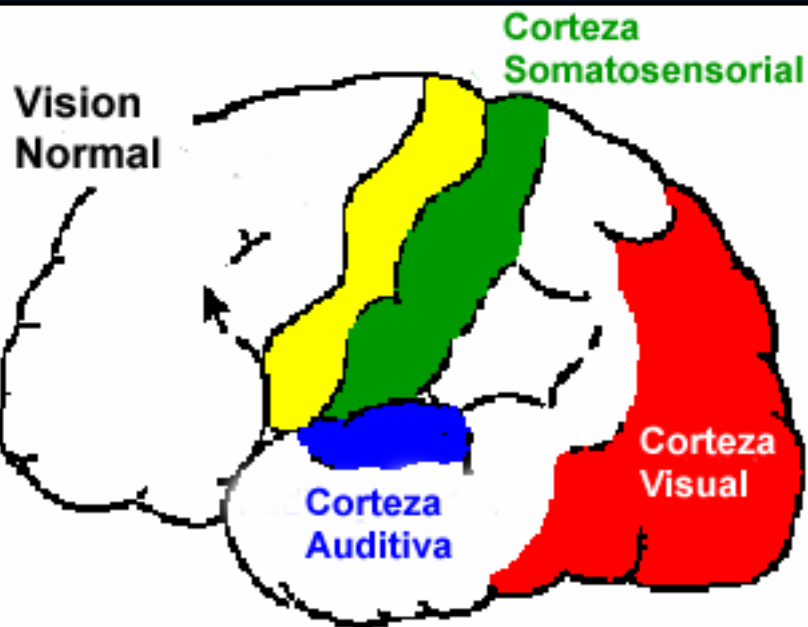
Design of electrodes for cortical stimulation





**Predicted and
measured responses of
cat area 17 cell
ensemble to upwardly
moving horizontal bar**



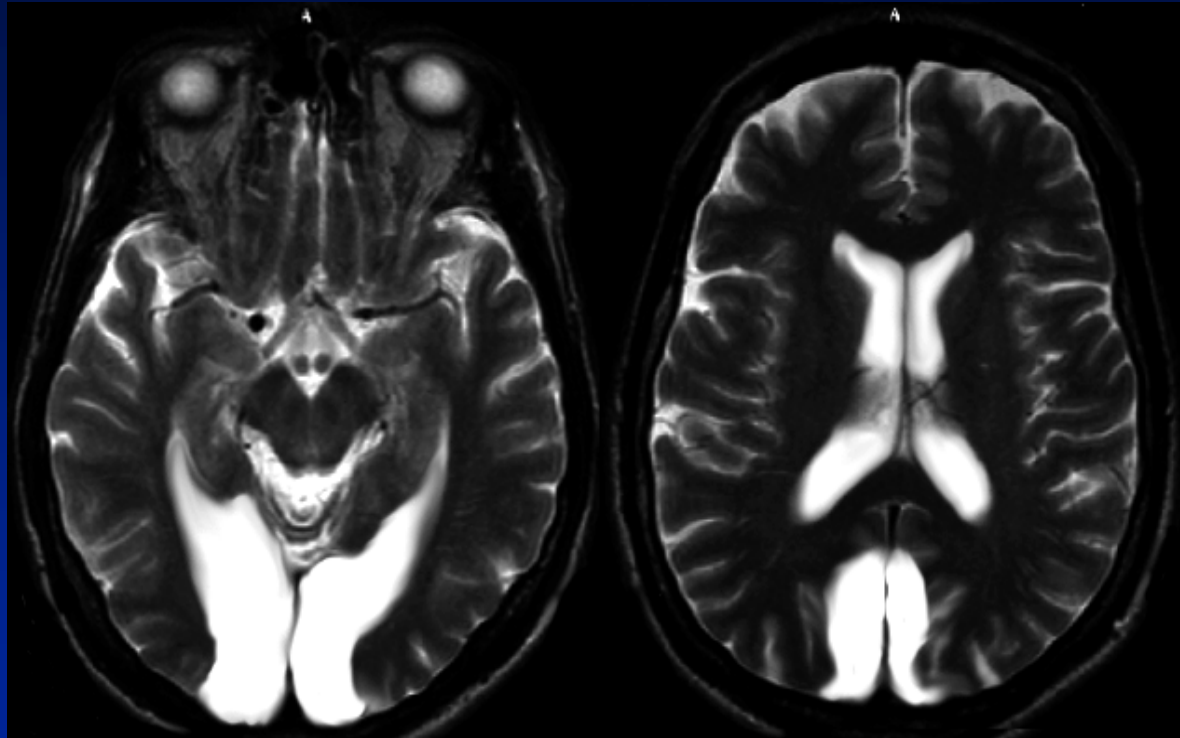


Is the occipital cortex of blind subjects able to process visual information?

Braille alexia

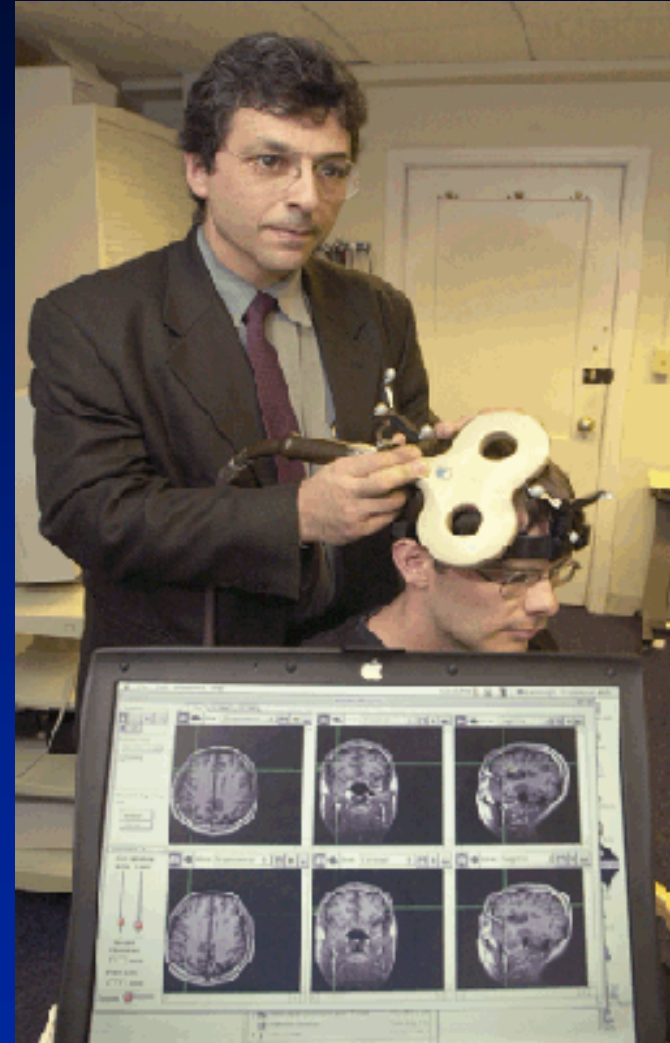
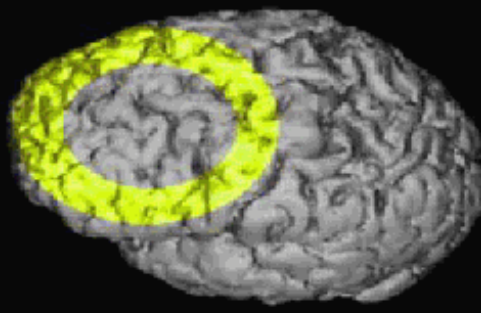
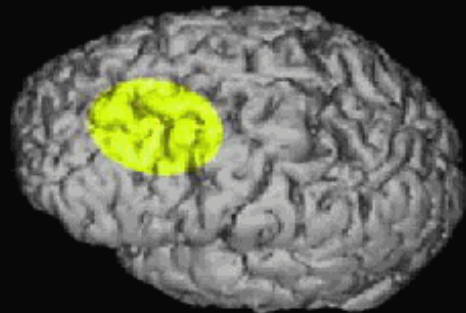
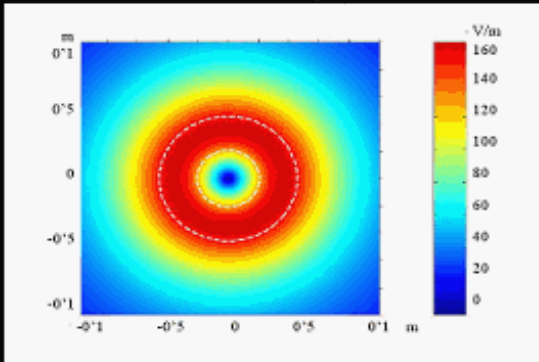
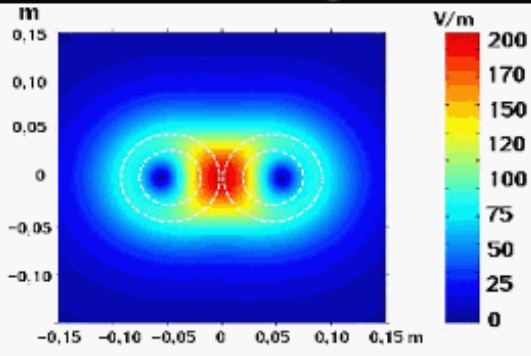
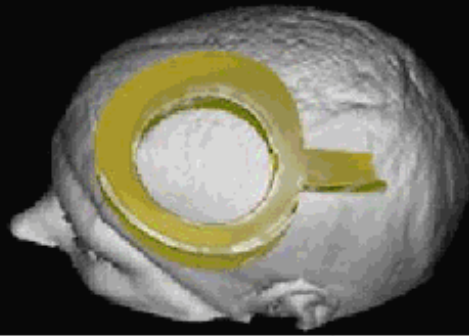
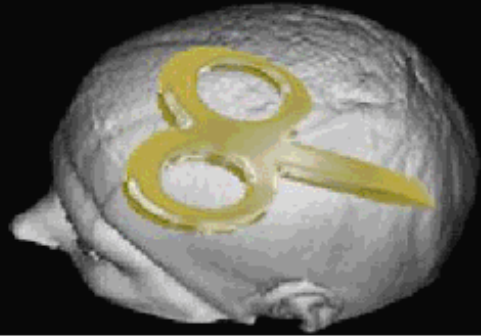
Lesion study

- 54 y/o woman
- Blind “since birth”
- Braille since age 7
- Braille 4-6 h/d
- Unable to read Braille after transient coma
- Normal neurological exam

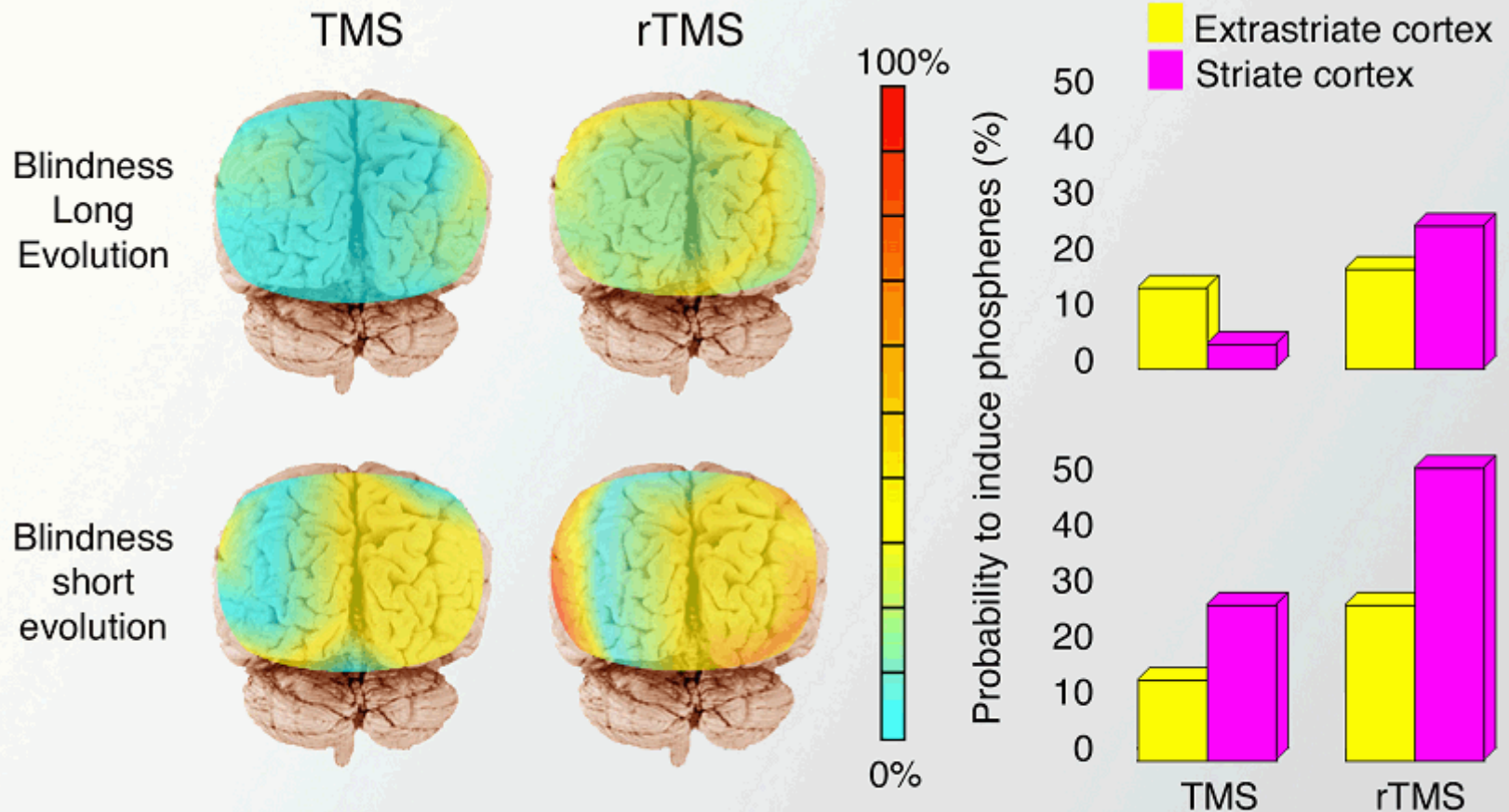


Pascual Leone et al. 1999

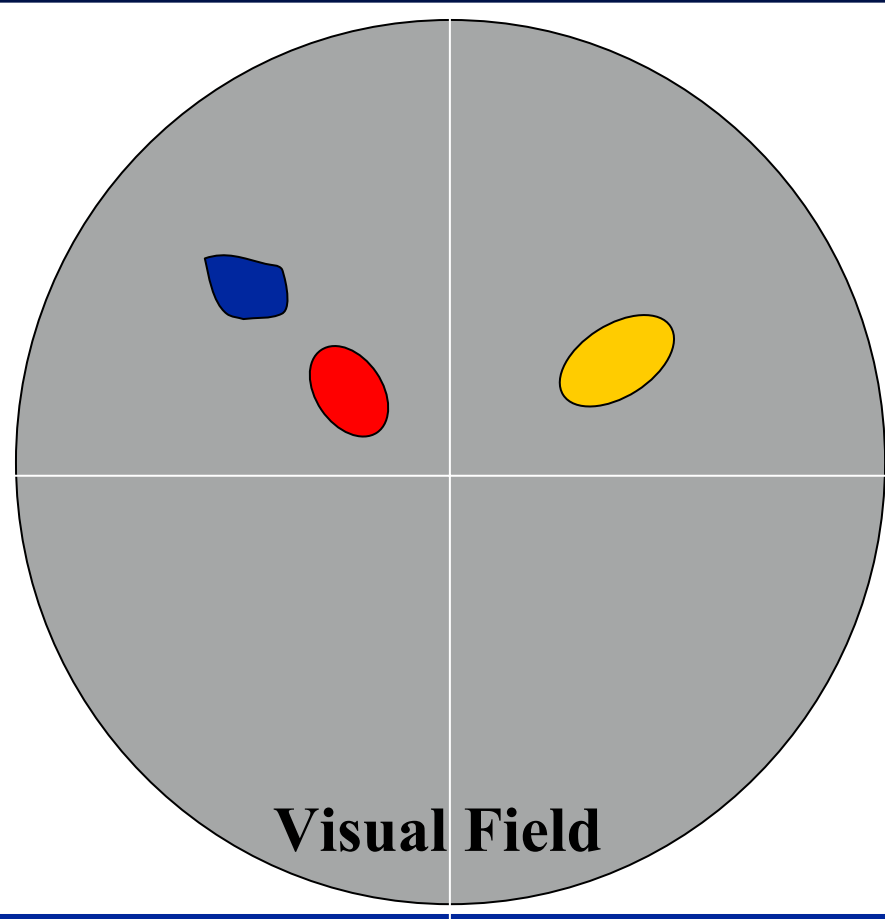
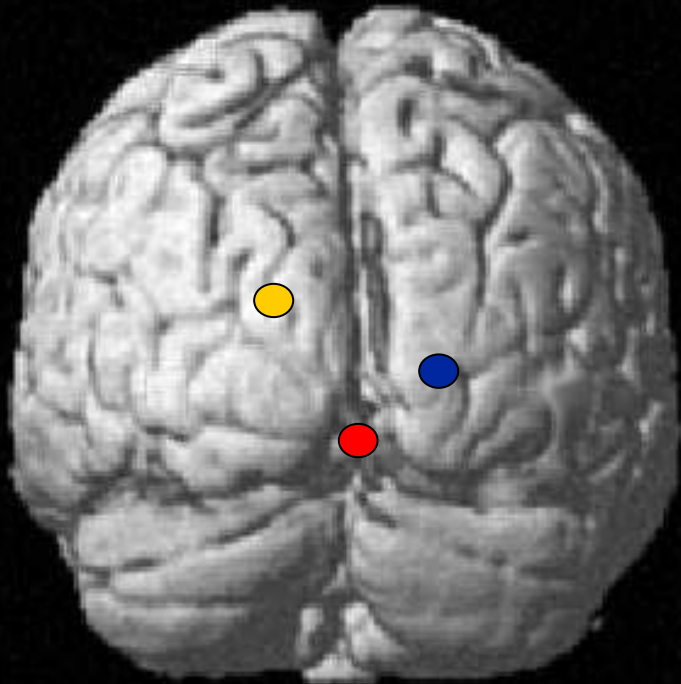
Mapping the human visual cortex using TMS



Perception of phosphenes in blind subjects



Examples of retinotopic mapping of TMS induced phosphenes in blind subject #8



- **How many electrodes are required to produce a useful visual sense?**
- **How stable are the phosphene thresholds on a day by day basis?**
- **How far apart can a pair of electrodes be positioned and still produced contiguous phosphenes?**
- **Does patterned stimulation produce patterned percepts?**

Conclusions:

- ✓ If we can understand more about the fundamental mechanism of neuronal coding, and to safely stimulate nervous system, there will real potential to apply this knowledge clinically.
- ✓ Our results show that intracortical microelectrodes could be safely used in long-term applications, although more studies regarding safety and preservation of neuronal tissues as well as optimizations of stimulating parameters are needed preceding any clinical trial.

Never in the history have been so many new findings concerning neural prosthesis as have been achieved in the recent 10 years. Still there may be a long way to application of such findings in patients. However, it can be expected that, at least for some patients, effective therapies will be developed during the upcoming years.

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